DOCUMENT RESUME

ED 424 983 PS 027 163

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TITLE A Study of Children's Mathematical Experiences in the Home.
PUB DATE 1998-09-00
NOTE 24p.; Paper presented at the Annual EECERA Conference (8th, Santiago de Compostela, Spain, September 2-5, 1998).
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Case Studies; Diaries; *Early Experience; Family Environment; *Mathematics Activities; Mathematics Education; *Numeracy; Observation; Parent Attitudes; Parent Child Relationship; *Parents; *Preschool Children; Preschool Education

ABSTRACT

This study assessed parental attitudes toward early mathematics and examined the ways in which families initiate and support the development of young children's early mathematical concepts. Six families with preschool-aged children (4 girls and 2 boys) participated in this case study involving observation of family interactions, interviews with parents regarding their child's activities, and parental diaries detailing significant things that they felt their child had learned and new activities that the child had undertaken between observations. Participation began when the child was less than 2 years old, and for all families, 1 parent was at home for at least part of the day. The major findings indicate that: (1) all parents were able to report on the mathematical tasks that their children had undertaken, but only half recognized those tasks as mathematical; (2) only half of the parents identified mathematical tasks as being important for their child's development; (3) for parents mentioning mathematics, number and counting were mentioned most often; (4) during observations, all children experienced some mathematical tasks, all adult-initiated; (5) five parents developed mathematical activities for their children; (6) five children initiated their own mathematical tasks; (7) the longest mathematical activities were those in which the adult and child were actively involved in their development; and (8) the greater the parents' awareness of the importance of mathematical development, the more time spent on mathematical activities and the more engaging the activities. (Contains 32 references.) (Author/KB)

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A Study of Children's Mathematical Experiences in the Home

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Abstract

Problem

Arithmetic activity is seen in cultures throughout the world (Saxe 1982). The use of body parts to aid every day counting seems universal just as infants and very young children seem to have an intuitive sense of numerosity (Wynn 1992). Since cultural influences are important it seems essential to find out more about how early mother and child interactions and other ecological variables impact on early arithmetical development. There is a need to understand better how language and memory, problem solving and schema-based knowledge interact with early teaching methods and ecological content.

Aims

This study aims to investigate important influences on arithmetical development

- How social discourse supports number and arithmetical development
- The nature and quality of early parent - child activities and number games (Saxe et al 1987 Stevenson , Lee, Chen, Stigler et al 1990)

Background

Comparative studies of North American and Asian children suggest family expectation may contribute to achievement. A high value placed on mathematics by Asian parents leads to more help and support at home (Crystal and Stevenson, 1991) and expectations of mathematical excellence may lead to increased effort (Stevenson et al 1990). Interestingly, however, in the early years emphasis on arithmetic by American parents (Stevenson and Stigler 1992) means that their pre-school children have a better understanding of basic number concepts. If cultural differences in the value placed on home and school mathematics are found to be so important, then a descriptive analytical study on parents arithmetic practices in an English context might shed valuable light on arithmetical development.

Research Methods

- A small case study involving six families with pre-school children
- Non participant observation of the child and family interactions
- Parental diary detailing significant things that they feel their child had learned and new activities that the child had undertaken between observations

Major findings

Data collected have been analysed in order to :-

- Assess parental attitudes to early mathematics and the importance that it is accorded
- Identify and describe the ways in which families initiate and support the development of young children's early mathematical concepts and attempt to determine whether parents are able to capitalise on their child's developing skills.
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Implications for practice

The findings will be fed back to parents for validation. Their views will be solicited and the implications will be considered.

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A study of children's mathematical experiences in the home

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Introduction

Arithmetical activity is seen in cultures throughout the world (Saxe 1982). The use of body parts to aid every-day counting, for instance, seems universal just as infants and very young children seem to have an intuitive sense of numerosity (Wynn 1992).

Many cultures have systems of what is recognisably mathematics but totally unlike school mathematics as we know it. These systems serve the needs of the cultures in which they exist. Gay and Cole (1967) involved in a mathematics project with the Kpelle in Liberia found that their culture affected the mathematics in which they were proficient. Kpelle adults, for example, were much more competent in their ability to estimate volume accurately than American adults but American adults outperformed the Kpelle in estimating long distances. Through this work and other studies it can be concluded that "mathematical knowledge may thus become connected to the activities through which that knowledge is acquired" (Nunes and Bryant, 1996, p104). Other authors such as Ascher (1991) and Zaslavsky (1973) give many similar examples and a study on Brazilian street children by Nunes, Schliemann and Carraher (1993) found that the Brazilian street children were very successful in street mathematics but not successful at the mathematics presented to them in school. This indicates that early experience and culture make some difference to mathematical aptitude. It therefore seems essential to find out more about how early mother and child interactions, in the context of games and mathematical activities, and other ecological variables influence children's early arithmetical development and how differences in attitude, culture and the child's early experiences influence his or her learning.

To explore this question we need to understand better the way in which language and memory, problem-solving and schema-based knowledge interact with early teaching methods in the home and pre-school setting.

Background

Studies of Chinese, Japanese and American Children (Crystal and Stevenson 1991; Stevenson et al 1986; Uttal et al 1988) suggest that family expectations may contribute to later achievement. Asian parents, as opposed to American parents, expect academic excellence in mathematics and interpret low achievement in terms of the need for increased effort and hard work. Because their expectations are higher Asian parents evaluate their children's attainment in modest terms. American parents, on the other hand, tend to regard low attainment as lack of aptitude for mathematics (Stevenson et al 1990). They are much more easily satisfied with their children's progress and have "excessively positive attitudes" (Stevenson et al 1993) towards their children's attainment in mathematics. Interestingly, however, in the early years American parents emphasise arithmetic more than Asian parents (Stevenson and Stigler 1992) and American pre-school children have a better understanding of basic number concepts. In school age children, however, Asian parents help their children between two and four times as much as American parents who do not value mathematics as much as sport, for instance. Crystal and Stevenson (1991) and Stigler, Smith and Mao (1985) found a high degree of parity between the way in which children regarded themselves and their actual school achievements.

A similar study by Kwok and Lytton (1996) compared the levels of mathematical achievement between Canadian and Hong Kong Chinese children and looked at the relations between perceptions of children's competence and mathematical achievement. It was found that while Canadian parents rated their children's competence higher than the Hong Kong Chinese parents, in actual fact, when they were tested the Hong Kong Chinese children out-performed their Canadian counterparts. Canadian parents, it was found, were generally satisfied with their children's performance, which led to reduced motivation on the part of the Canadian children and a complacency with regard to the effort needed to improve on their mathematical performance (Kwok and Lytton 1996).

The later development of the mathematical competence of children can therefore be associated with the expectations and attitudes of their parents. It seems that positive

attitudes, high expectations and encouragement by the parent leads to higher achievement of the child, and that low expectations and lack of encouragement can lead to complacency which reduces the child's motivation.

Geary et al (1996) add another dimension to this and relate mathematical performance in some areas of the curriculum to the quantity of schooling that has been received. They cite this as being "one important source of national difference in mathematical achievement" (Geary , Bow-Thomas , Lui and Sigler 1996).

When looking at research concerning younger children it can be found that there is evidence which suggests that experiences prior to school are important for the attainment of some mathematical skills during statutory education (Munn 1994). The early development of number skills in young, pre-school children has been well documented (Suggate, Aubrey and Pettitt 1997) and there is much evidence to indicate that young children may have extensive mathematical understanding usually of an informal kind before they enter school. Hughes (1986 p.24-36) gives examples of children's pre-school mathematical abilities. In one experiment 83% of his sample were able to solve small-number addition and subtraction problems connected with cubes being placed in or removed from a box in front of them.

American children as discussed above have been shown to have a higher understanding of some mathematical concepts than their Asian counterparts at school entry. In the United Kingdom, Aubrey (1993 and 1994) reports on studies of children in British reception classes (usually aged four and five years) and concludes among other things that "The high attaining children were well towards mastery of level 1 of the National Curriculum Mathematics Attainment Target 2 for Number on school entry. The low attaining children brought into school a range of informal competencies and a less stable conventional knowledge" (Aubrey 1993 p.39).

In other words, there is a wide variation in the competencies of children in mathematics on entry to school, presumably, as a result of their different pre-school experiences in the home and in out of home pre-school settings. For example, Munn (1994) found that

few children were able to recognise counting as a mathematical activity and that most of them implied that counting was linguistic only.

Davies and Brember (1998) in their study of the effects of pre-school experience on the mathematical attainment in year two, for seven year-olds, found that pre-school experience appeared to have an effect on children's mathematical attainment. They were largely looking at pre-school provision in terms of the quality of nursery education, nevertheless, it can be argued that as children spend the majority of their waking hours at home that this must have an effect also.

From the above discussion it can be seen that there are many influences on a child's mathematical attainment. There is a complex interaction between culture, parental attitude and expectation, as well as pre-school experience and schooling. It has been demonstrated that culture imposes discernible differences on mathematical aptitude and early influences impinge on a child's later mathematical development.

Parents have a vital role to play in the development of their children and research indicates that they can given the right circumstances be effective teachers. Connor, Knight and Cross (1997) looked at the influence of parent - child interactions on young children's competence in problem-solving. They found that there was a great deal of "parental scaffolding" (Wood and Middleton 1975) and their results indicated that parents can be fairly sophisticated teachers in informal settings and "provide additional evidence for the relationship between parent-child interaction behaviours and child measures of success" (Connor Knight and Cross 1997, p. 335). Therefore it seems to be perfectly possible that if parents have an enthusiasm for and can see the importance of mathematics education for their young children then they will have the ability to support and extend the children's learning in this area.

The question of parental attitude, cultural belief and expectation and how they are linked to the development of a child's mathematical aptitude and achievement in the United Kingdom is an interesting one that needs to be explored further.

Aims

The study, of which this paper is a part, sought to investigate children's pre-school experience and the development of their mathematical skills. The focus was on:

- the influences on the arithmetical development of the child;
- how social discourse supported number and arithmetical development;
- the nature and quality of early parent - child activities and number games (Saxe et al 1987; Stevenson, Lee, Chen 1993; Stigler et al 1990);
- whether parents were able to capitalise on their child's developing skills.

The study intended to explore and describe some of the factors in the home that may affect the development of mathematical ability. For example:

- parental attitudes, expectations and input;
- interaction between the child and his parents or more knowledgeable others including brothers and sisters.

The specific aims for this paper are to report on the findings from the first stage of data collection. The paper, thus, explores:

- cultural differences in parental attitude and its influence on attainment;
- parental attitude and its link to achievement in the UK.

Research Methods

i) Introduction

A case study of six families with pre-school children was carried out. This was small in terms of numbers and qualitative in design. The overall goal was to identify and describe the ways in which families initiated and supported the development of their young child's early mathematical concepts. The case study approach seemed appropriate in this instance because the study was intended to be an examination of individual development and interaction. All families are unique, the writer was exploring their individuality in order to make an in-depth study of single cases. Recent work by Pollard (1996), which adopted similar approaches in exploring the learning of children aged four to seven years, yielded important information about the influence of home relationships.

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ii) Subjects

The sample was drawn from the local area. Although this cannot be seen as a representative sample, writers such as Bogdan and Bicklin (1982) and Lincoln and Guba (1985) have emphasised that representativeness is not crucial in interpretative investigations, as purposive sampling "increases the scope and range of data exposed... and the full array of multiple realities will be uncovered" (Lincoln and Guba 1985, p.40). The intention here is to maximise information and not to make generalisations from data collected.

Volunteers were sought from:

- a local playgroup;
- an informal mother and baby group;
- a local factory;
- a local school.

It was hoped in this way to get a diversity of families and maximum variation for quality.

Families were chosen on the basis of:

i) all children were under two years of age at the time of the beginning of the study, the youngest being one year four months and the oldest one year ten months;

ii) one parent was at home for at least part of the day, allowing for significant parental input and accessibility for the researcher.

Families recruited had the following profile at the beginning of the study:

- in all families both parents lived in the family home;
- all fathers worked full time;
- two of the children had an older brother or sister;
- there were four girls and two boys.

The employment situation of the mothers varied as shown below:

- two mothers worked part-time;
- two mothers were at university or college;
- two mothers were at home full-time.

iii) Methods

Non-participant observation of the child and family interactions was carried out. Interactions between parent and their child, taking into account the emotional and physical environment in which these interactions took place, were explored.

This non-participant observation technique was used by Davie et al (1984) in the homes of young children, and by McLean (1991) in her study in pre-school classrooms. McLean (1991), however, supplemented her data gathering method, as does this study, by using interviewing techniques to explore some of the personal beliefs and perceptions of the participants.

During the initial interview parents were asked a variety of questions to find out the types of activities that their child engaged in and what they felt was important for their child's development.

Parents were also asked to keep a diary detailing significant things that they felt their child had learned and new activities that the child had undertaken between observations. Discussion took place with the parent at the follow-up visit to ascertain whether they could recognise the mathematical progress of their child and whether they had encouraged their child in this aspect of his/her development.

iv) Analysis

a) Initial Interview

Notes taken at interview were later analysed and the number of times that mathematical tasks and activities were mentioned by the parent during the interview were counted. These instances were put into two categories (see table one).

The first category comprised instances where the parent had mentioned that the child had undertaken a mathematical task or activity. Any reported activity that had some mathematical content or included skills that could be identified as those needed for mathematical development, such as building and recognising categories such as colour, was included.

Some of the activities reported by parents were:
"doing puzzles";
"making towers but also sticking pieces on everywhere";
"putting things in and taking them out again";
"if (child) has a biscuit, she always wants to give another to her sister".

The second category was concerned with how often mathematical tasks or activities were mentioned as an important feature of the child's development.
Some of the desired elements mentioned were:
"count to ten, she uses words but I don't know whether she is matching one to one";
"building blocks";
"things like full, empty, half full";
"learning numbers".

b) First Observation
Data from the first observation were analysed to see how much time during an hour period was devoted to carrying out mathematical activities. All areas of possible early mathematical development were included such as sorting, matching, fitting shapes together, stacking and lining up blocks or other items as well as counting, reference to numbers and reading "counting" books.

A record was made of the time spent on each mathematical activity and whether the child was engaged in the task or observing. The initiator of the task, child or adult, was noted. Whether the task developed further was recorded along with who was responsible for that development.

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c) Linking the Data

The two sets of data were compared to see whether any pattern had emerged which linked parental attitude and expectation to the quality of mathematical tasks undertaken by the children during the observation.

The diary was not analysed during this phase of the research.

Results

Results from the initial parental interviews and from the first observation of the child and parent are given below

i) Findings from initial parental interviews

Table one summarises the initial interviews.

→ *Insert table one*

Analysis of the initial interviews with parents indicated that :

- all parents were able to report on the mathematical tasks that their children had undertaken but only half of them actually recognised those tasks as mathematical;
- when parents were asked what things they felt were important for their child's academic and educational development they identified between three and nine topics that they felt were important, however, only half of the parents interviewed identified mathematical tasks as being among these;
- only one parent mentioned mathematics in more instances than mathematically unrelated topics;
- of those parents who mentioned mathematics, number and counting were mentioned most often, with other mathematical concepts being mentioned by only one parent.

ii) Findings from initial analysis of data from the first observation

Table two summarises the initial observations.

→ *insert table two*

The data collected at the first observation were analysed and it was found that:

- all children experienced some mathematical tasks during the observation;
- all observations included mathematical tasks that were adult initiated;
- all children participated in mathematical activities in which they were actively engaged;
- five children experienced mathematical tasks at which they were observer;
- five parents developed one or more mathematical activities for their child;
- five children initiated their own mathematical task or tasks;
- four of the six children engaged in longer mathematical tasks of two minutes or over;
- the longest mathematical activities were where the adult and child were both actively involved in its development;
- twenty five activities were less than one minute in length;
- nine activities developed into longer tasks of over two minutes;
- four tasks lasted about three minutes;
- one task lasted for over fifteen minutes.

Discussion and Conclusions

Preliminary results from the first interviews given below seemed to indicate that there was a lack of parental awareness of things mathematical and that mathematical development is not high on the parental agenda.

Comparison of the results tables seemed to suggest that:

- There was some association between mathematical tasks reported by the parents and their awareness of the importance of mathematical development and the time spent during the observation period on mathematics, that is, the greater the awareness the more time spent. Child C, for example, spent more than twenty-eight minutes on mathematical tasks during the first observation. During the initial interview her mother had reported seven mathematical tasks and had identified five mathematical topics out of nine as important for her child's development. Child B, on the other hand, spent less than two minutes on mathematical activities. Her mother, at

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interview, had reported two mathematical tasks only and identified two mathematical topics out of ten as important for development.

- Parental awareness of the importance of a child's mathematical development and the number of mathematical tasks reported appeared to be associated positively with the parents' ability to develop mathematical experiences with their children. Child C, for example, spent more than twenty-eight minutes being engaged in tasks with some adult development and child H spent fifteen minutes thus engaged. Child B spent less than two minutes, child E less than four minutes and child I less than two minutes. Child F proved the exception spending about fourteen minutes engaged in tasks with some adult development.

- Parents who demonstrated a heightened awareness of mathematical activity in the first interview demonstrated in the first observation that they were able to challenge their child mathematically, encouraging and supporting his or her development. Longer mathematical activities supported and developed by the parent and child together were experienced by child C and child H. Child F also experienced longer supported activities even though mathematical development was not highlighted as a priority at interview. He did not, however, experience as many engaging mathematical experiences as child C and child H. The other three children all experienced only short activities and no collaboratively developed activity.

- Child C whose parent had attached a great deal of importance to her child's mathematical development at interview spent more than twenty-eight minutes out of sixty on mathematically-related tasks, while those children (except child F) of parents who attached the least importance spent less than ten percent of their time on mathematically related tasks during observation.

- The most successful activities in terms of the child's opportunity to engage mathematically and refine his/her thinking were those in which both parent and child participated in its development. This can be demonstrated be the quality of the exchange between child and parent two examples of which are given below.

Example one

Child C was playing with a small pot containing a collection of nine small polished stones. She had removed six one by one and had placed them on the table.

Mum "…. one , two, three, four, five six".

C Continues to remove stones from the pot.

Mum "…seven, eight, nine. nine stones". Picks some stones up.

C Removes stones from Mum's hand and puts them back on the table.

Takes the pot from Mum and puts it on the floor.

Puts stones in the pot one at a time.

Mum "One, two, three, four, five, six".

C Thinks that she has lost one (or more). Looks on the floor and under the pot. Tips the stones out of the pot onto the table (There are six). Puts them back one by one.

Mum "Pink, black, blue, brown, green"(claps). "Yeah, all gone".

C Picks up a Postman Pat book and puts it on the table.

Takes stones out of the pot, one at a time, and puts them on top of the book. "Es".

Puts the pot on the table and puts stones in one at a time.

Mum "One". Puts a stone on C's head. C ignores. "Yellow, orange …..".

C Continues to put stones in pot one at a time.

Tips out stones onto the floor and puts them back one by one.

Mum "One, two, three, four, five, six". "Where have the others gone?" Under Guss?" (soft toy) " Eight, nine".

C "Ees". Picks up pot.

Mum "Are you carrying them?"

C Empties the pot. "Oh dear". Puts them back in one by one.

Mum "One, two, three, four ….. five, six, seven, eight, nine …..".

C Tips all but one stone out. Shakes the pot and enjoys the noise. The stone falls out.

Picks up the stone and repeats seven times with one stone each time.

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	Puts two stones in the pot. * shakes, listens to the noise. Stones fall out. Puts one back.
Mum	Picks up another stone and adds to the pot (there are now two stones in the pot)* . Repeats from * to * four times.
Mum	Replaces just one stone and C shakes. This is repeated seven times
C	Returns to the original game once. Puts all the stones in the pot and then takes them out. Puts one stone in the pot and shakes. Repeats. Puts two stones in the pot and shakes.

Example 2

Child H collected some play buttons from the shelf. Her mother encouraged her to play with them.

Mum	"Ooh, a pocket". Opens the jar. "Put one in your pocket, put another one in your pocket". "Where have they gone?"
H	Shows Mum that they are in her pocket.
Mum	Picks up buttons one at a time and puts them in (child's) pocket. "A yellow one, a blue one, a green one. Lets see what you have got". Looks at all the buttons in the pocket. "Why don't you put all the yellow ones in your pocket?" Shows H a yellow one.
H	Collects yellow buttons and puts them in her pocket.
Mum	* "Can you find another?"
H	Finds another yellow button and puts it in her pocket.* Continues * to * until all of the yellow ones are gone
H	"Gone".
Mum	"What shall we put in that other pocket?" "Shall we try the orange ones?" Puts an orange one in H's pocket. "Has it gone in?" "Hide all the orange ones".
H	Picks up a red button.
Mum	"You have got an orange one in that pocket".

H	Takes the orange one out of her pocket and gives it to Mum.
Mum	"Are you going to collect red then?"
H	Puts the red button in her pocket.
Mum	"Anymore red ones?"
H	Picks up some red buttons,

There are two red buttons left on floor and three in Mums hand.

Mum	"Are there any more?"
H	"Gone".
	Takes yellow buttons out of her pocket and tries to line them up.

- The long activities which challenged the children's ideas all had the common element of capturing and holding the child's interest. These parents, as can be seen above, were willing to go along with the child's ideas helping, supporting and suggesting developments.

Evidence of arithmetical activity, then, can be seen in the homes of all of the children in the study and it can also be seen that in some families, at least, children are being supported in their early mathematical explorations. The study seems to indicate that greater expectation and positive parental attitude leads to more mathematical activity taking place. Already it can be seen that differences in attitude and ecological variables are likely to have an impact on the child's learning.

Mathematical activity was initiated more frequently by the adult than the child, but some parents had difficulty in either capturing the child's interest or in developing the task once the child had become interested. The children were given varying degrees of encouragement from their parents, from simply initiating an activity, to collaborating with the child and moving the child on in their mathematical thinking. It has yet to be seen whether early these early experience will make an impact on the child's later mathematical development.

All of the children in the study showed some mathematical awareness but the quality of experiences witnessed by the writer varied from child to child. It is impossible to say at

this point what the effects of this might be in the longer term. This report gives only the initial findings from a study that is intended to span several years. It is intended that some of the children and their families will be followed into pre-school and school. It is hoped that, in the future, the many questions arising from this work will be investigated in more depth. The next phase will be looking in greater depth at the children's mathematical progress. It will examine whether there are links between parental mathematical experiences and qualifications and the amount of mathematical activity that is evident, with the child, at home.

Table one

Findings from initial parental interviews

Child	Instances of child carrying out mathematical tasks reported by parent	Instances of parental identification of mathematics as important for development	Mathematical topics mentioned	Total number of topics identified as important for development
B	2	2	numbers counting	10
C	7	5	counting (three times) shape recognition number	9
E	2	0		6
F	4	0		7
H	6	4	shape recognition sorting counting numbers	10
I	2	3	counting matching sorting	10

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Table two

Findings from initial observation

Child	Number of mathematical experiences	Initiator	Development	Length of experience	Child participation
B	2	adult	none	less than 1 minute	observing
	1	adult	none	less than 1 minute	engaged
C	2	adult	none	less than 1 minute	observing
	1	adult	adult	less than 1 minute	engaged
	1	child	adult	less than 1 minute	engaged
	2	adult	adult and child	3 mins and 25 mins	engaged
E	3	adult	none	less than 1 minute	engaged
	3	adult	adult	less than 1 minute	engaged
	2	child	adult	less than 1 minute	engaged
	1	child	none	2 minutes	engaged
	1	adult	adult	2 minutes	engaged
	1	adult	none	2 minutes	engaged
F	1	adult	none	less than 1 minute	observing
	1	child	adult blocked	less than 1 minute	
	2	adult	adult and child	3 mins and 11 mins	engaged
H	2	adult	none	less than 1 minute	observing
	1	adult	none	less than 1 minute	engaged
	1	child	child	less than 1 minute	engaged
	1	child	child	2 minutes	engaged
	1	child	adult and child	15 minutes	engaged
I	2	adult	none	less than 1 minute	observing
	1	adult	adult	less than 1 minute	engaged
	1	child	adult	less than 1 minute	engaged

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